Design Specifics and Estimated Material Cost

Dean Walters

Engineering Operations
Nuclear Engineering Division
Argonne National Laboratory

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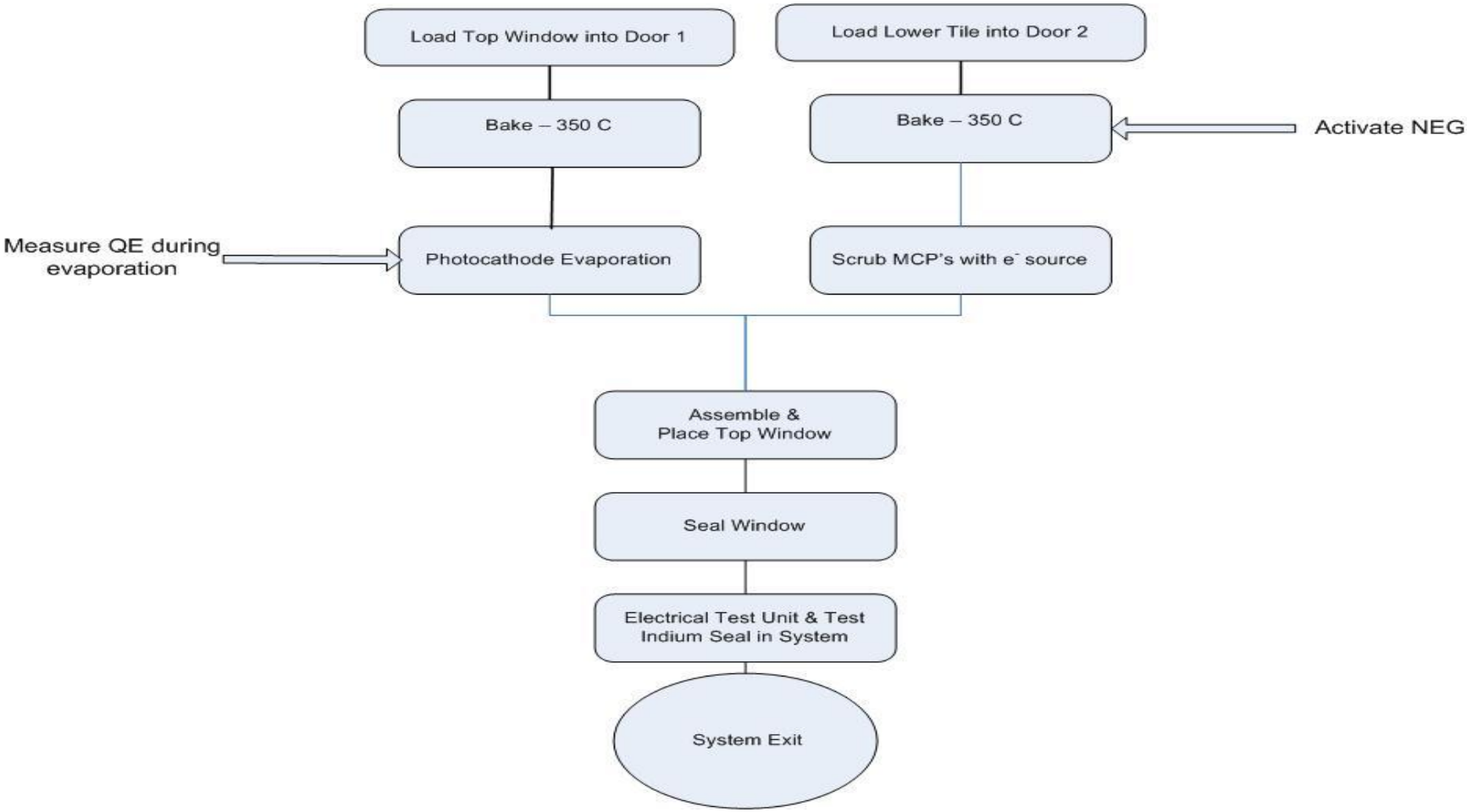
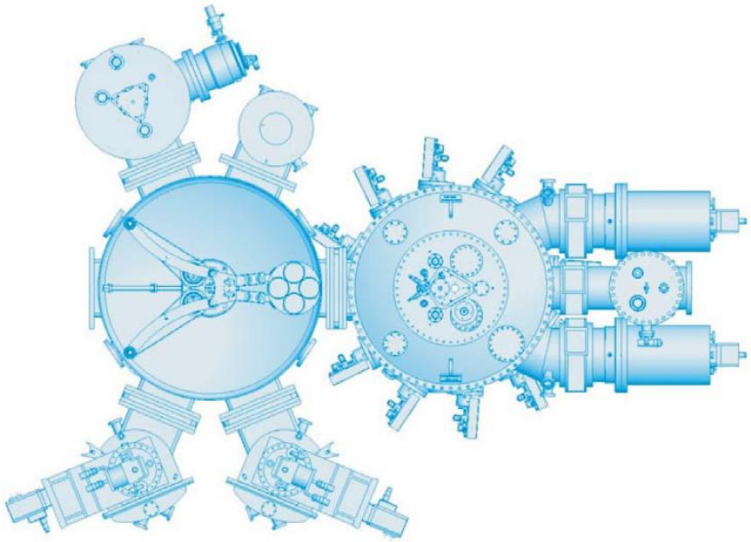
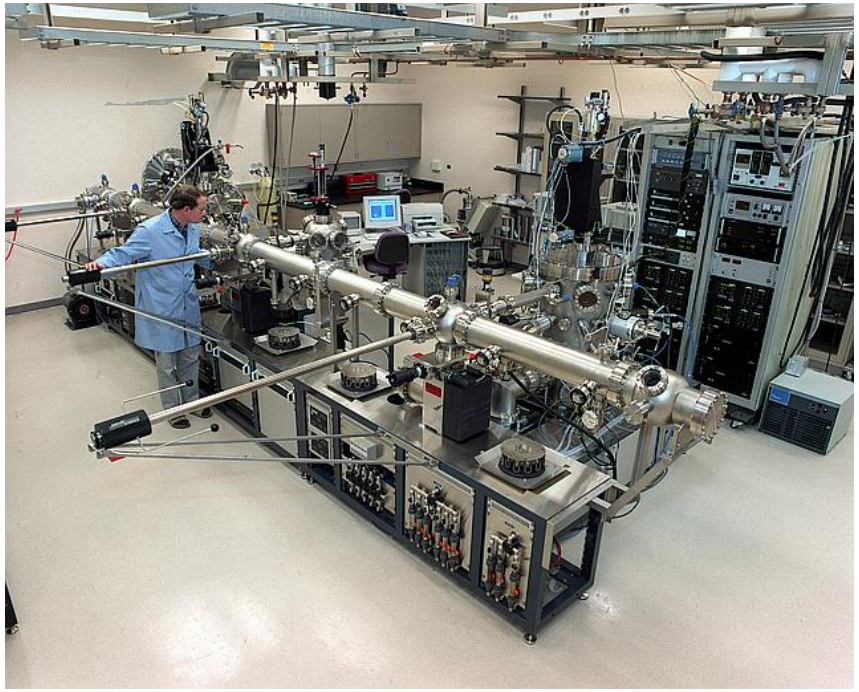
Material Processing Flow Chart



Design Concept

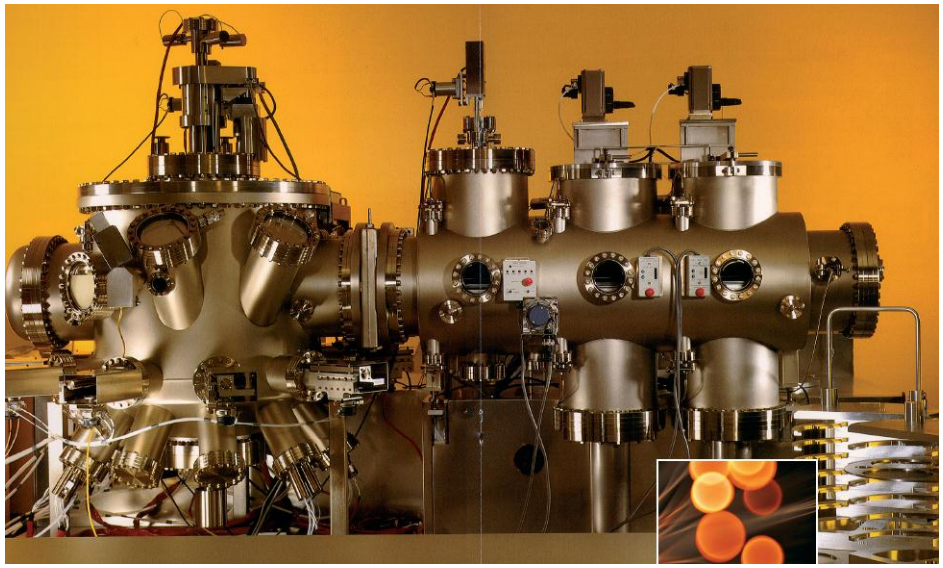
- Here are two ways to make a multi-process/multi-chamber system
- Cluster tool where each of the process chambers around the parameter is feed by a central manipulator.
- Linear tool where the samples are moved down a central tube.





Design Concepts

Examples of multi-chamber systems made by industry.



- From VG/Oxford

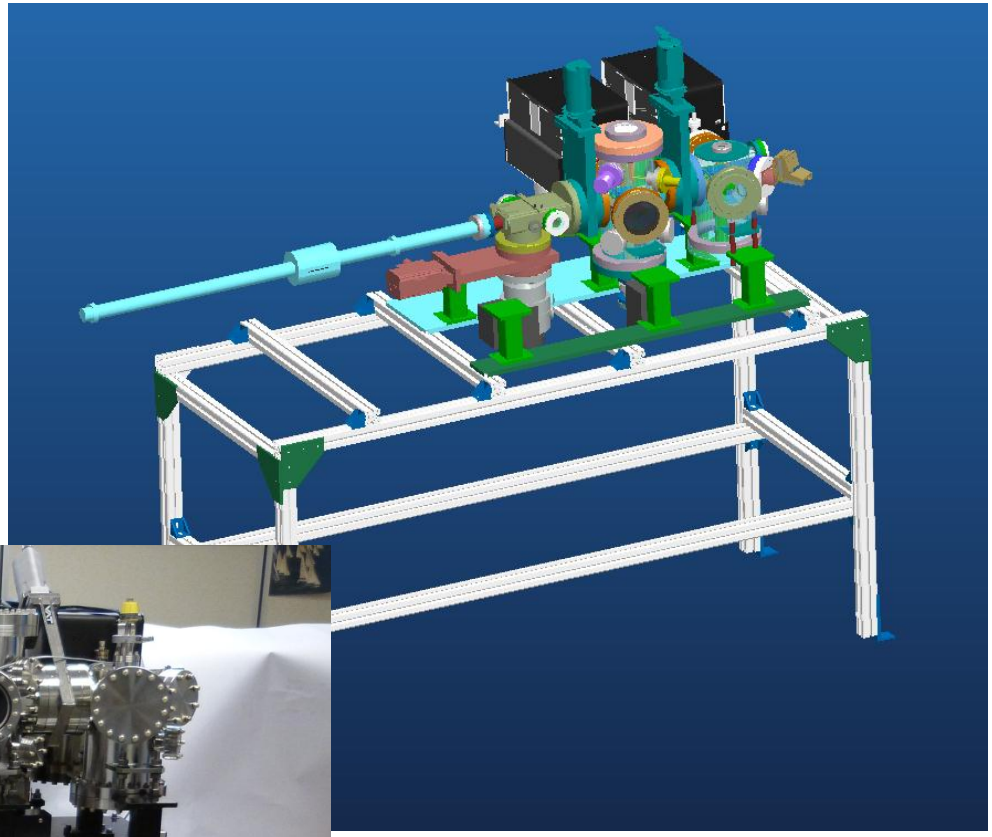
Oxide MBE System with Load Locked Effusion Cell

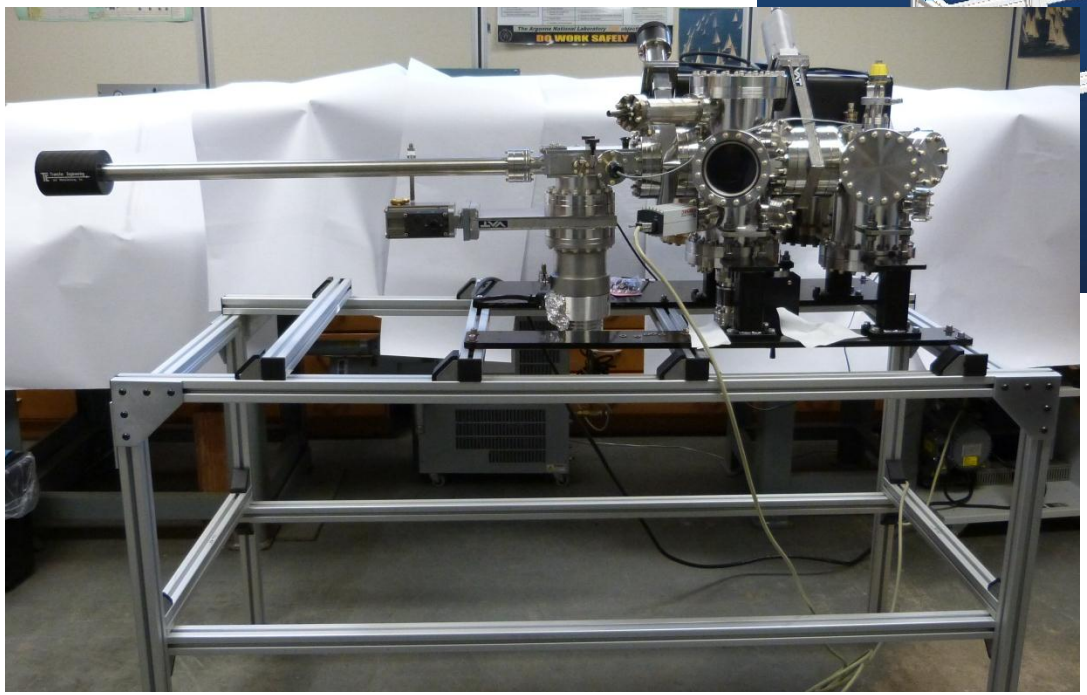
MBE System with STM Module

From SVT Associates

Design Concepts

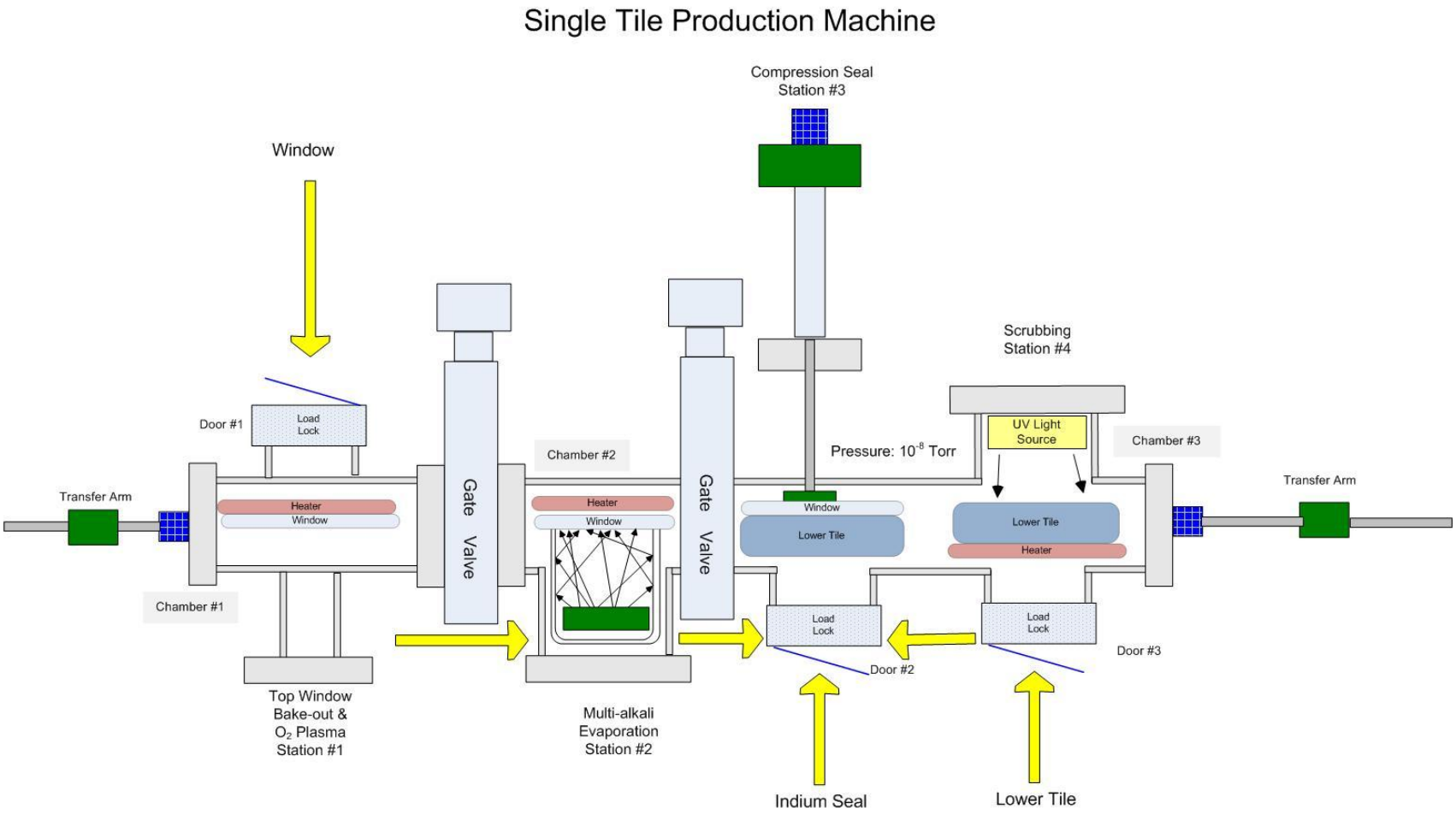
- Example of a linear UHV system using a transfer arm for sample transport.



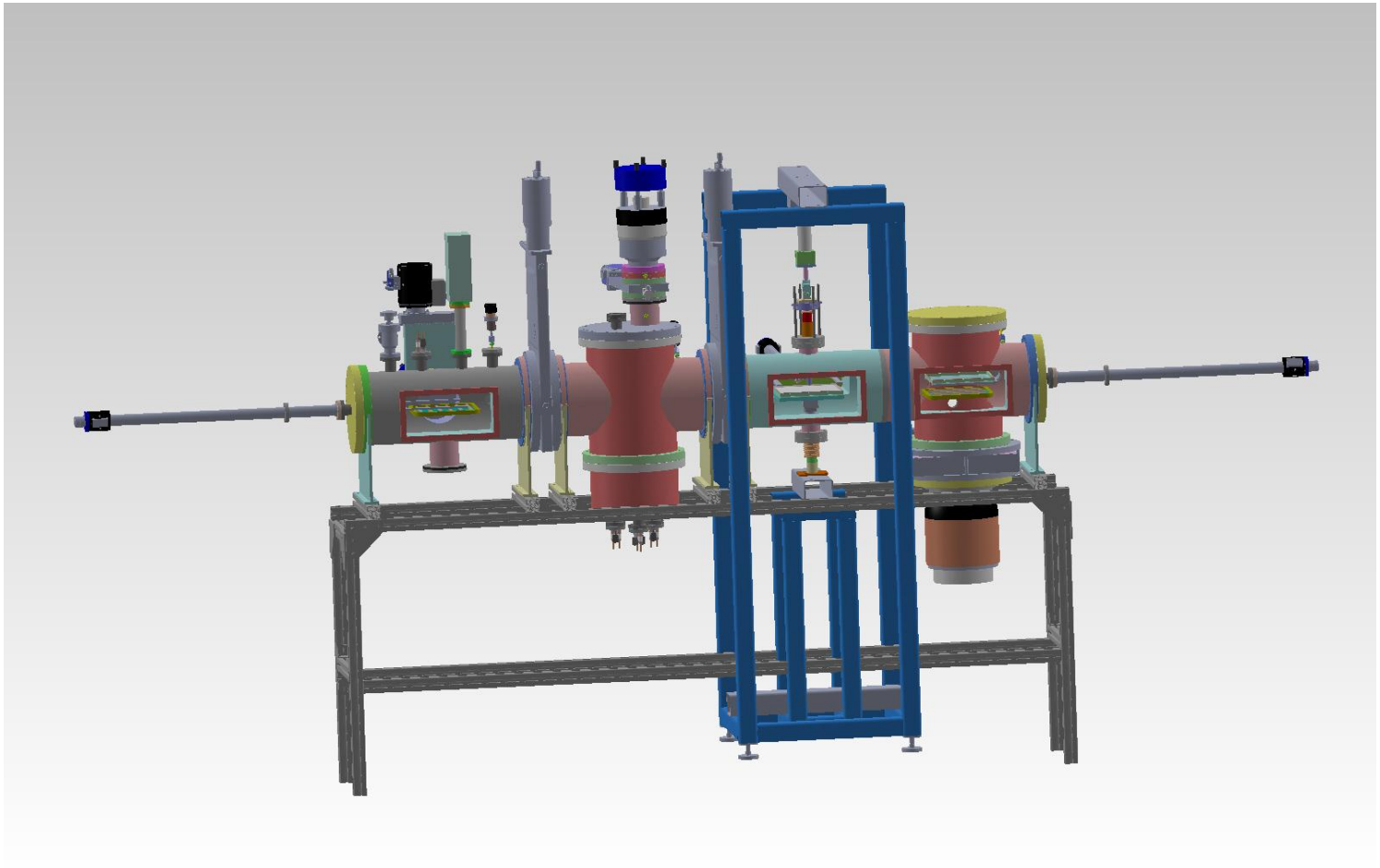


Courtesy of M. Virgo

Schematic of the Single Tile Process System

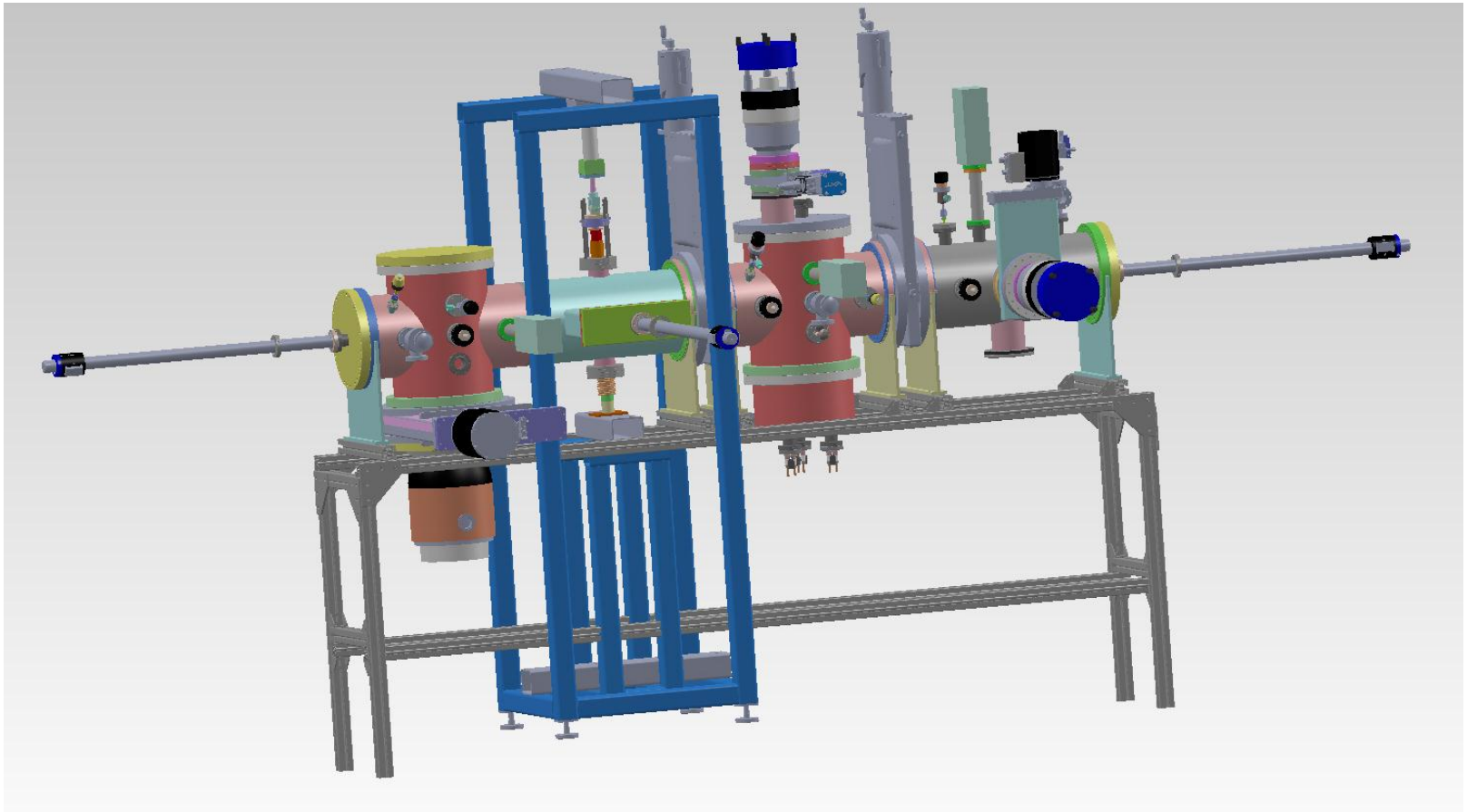


Single Tile System



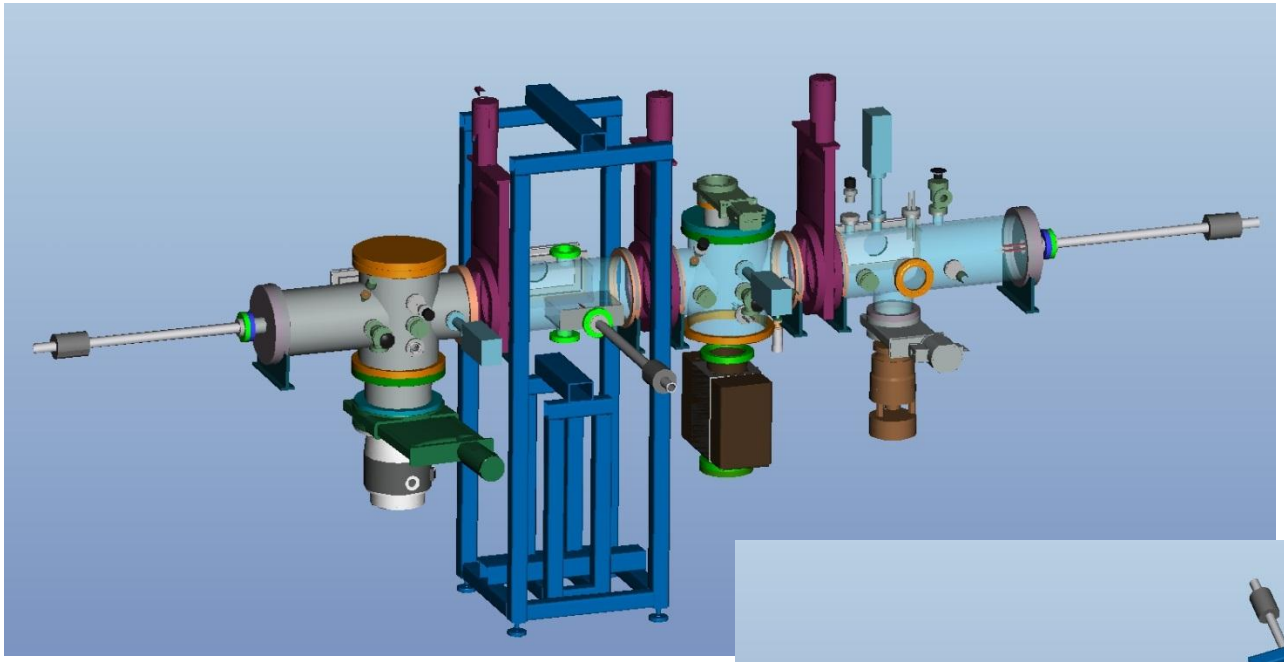
Progress of Design

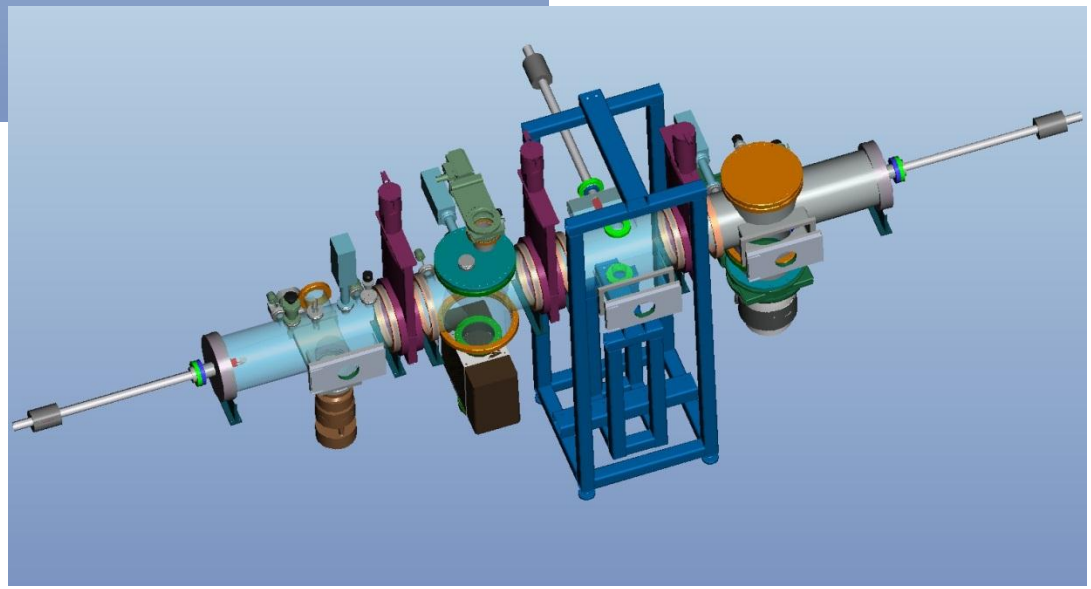
- What has been started
  - SolidWorks



Models

- Pro/Engineer

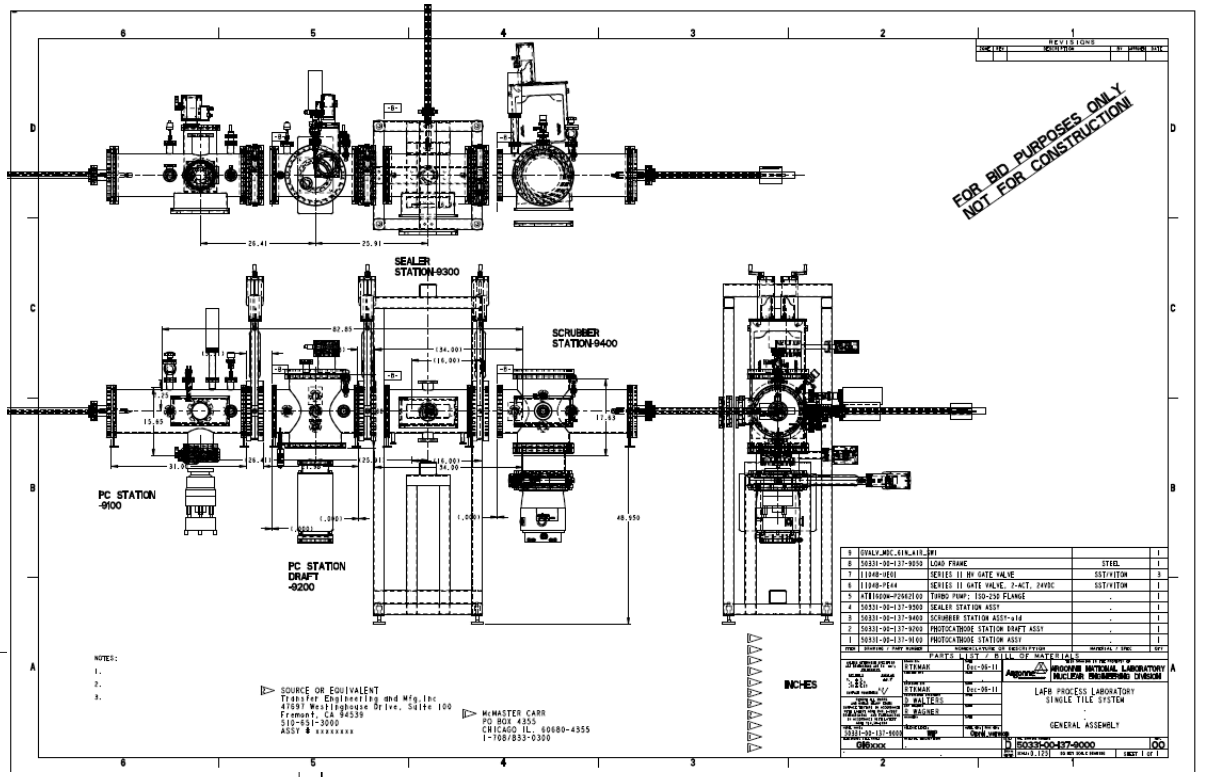


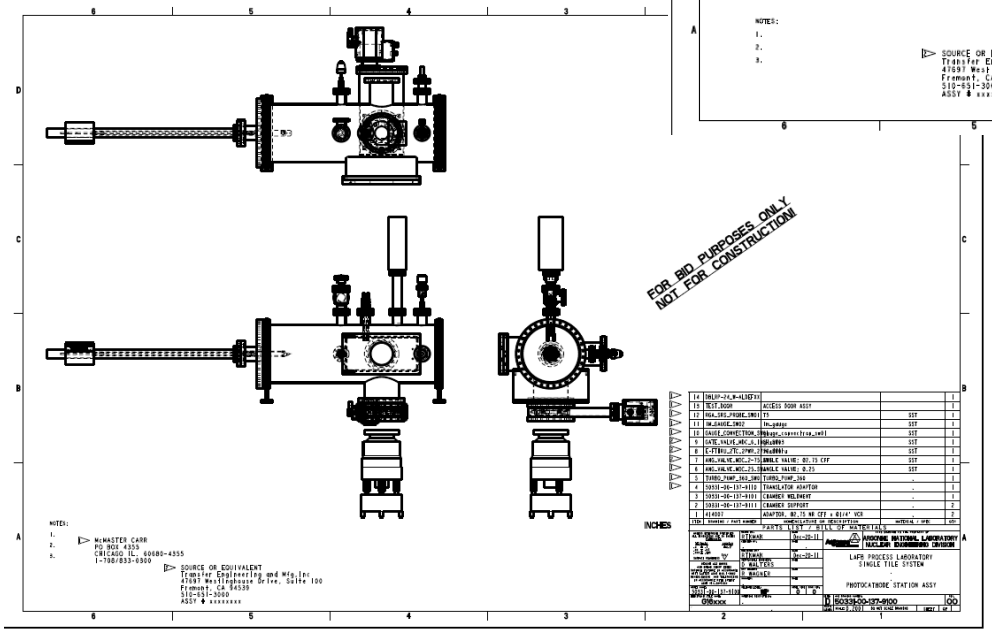


Courtesy of R. Kmak

Drawings

- Started on assembly drawings

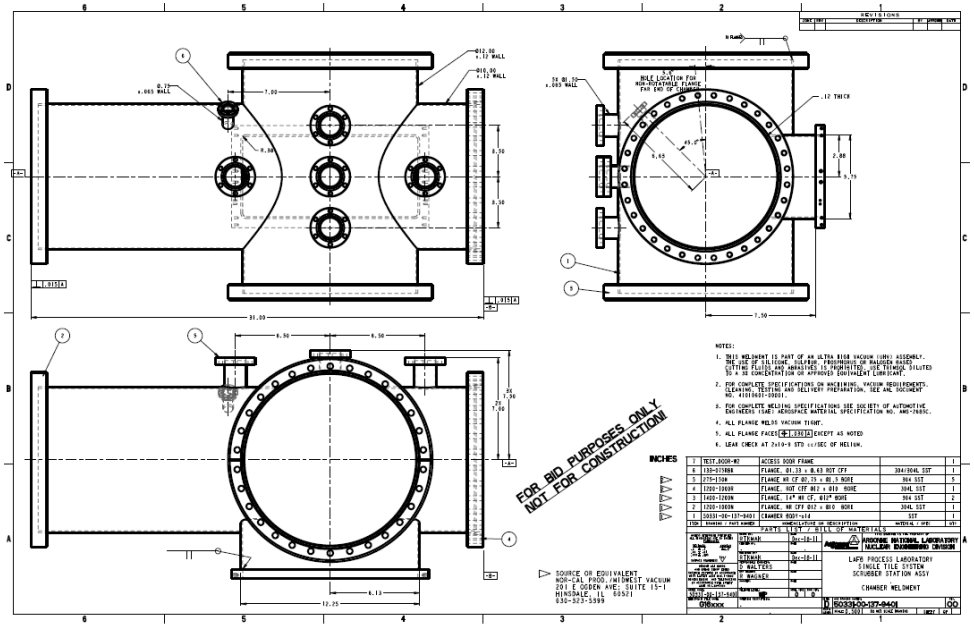


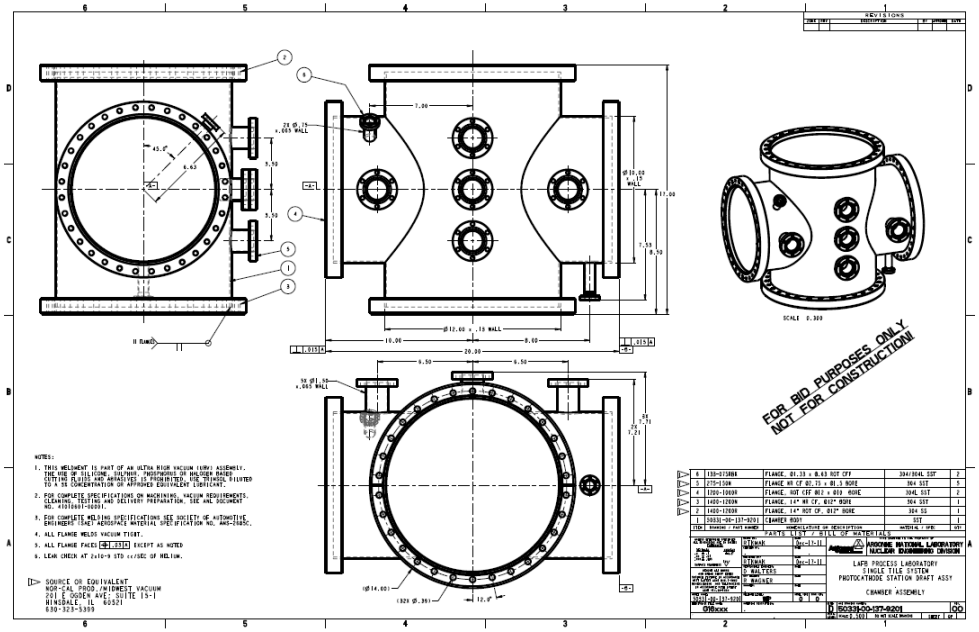


Courtesy of R. Kmak

Drawings

- Started on parts drawings



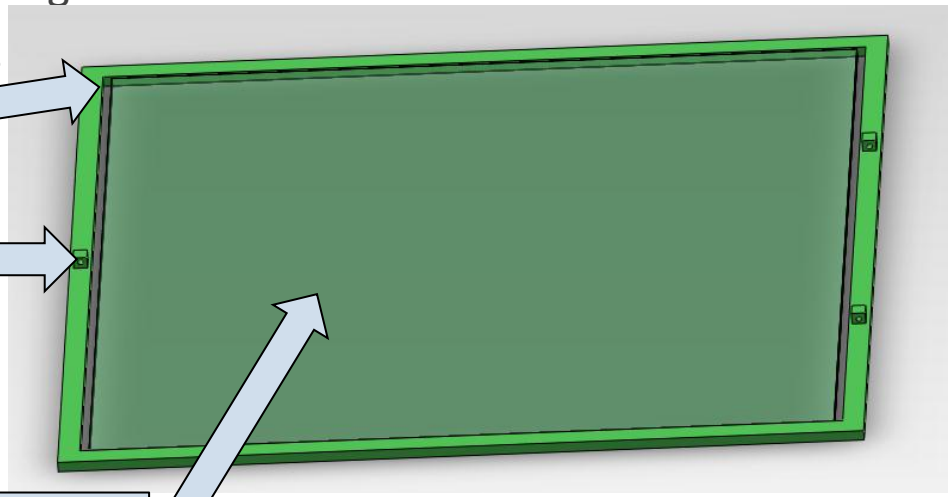


Courtesy of R. Kmak

Meeting D. Walters drw@anl.gov

What needs to be done

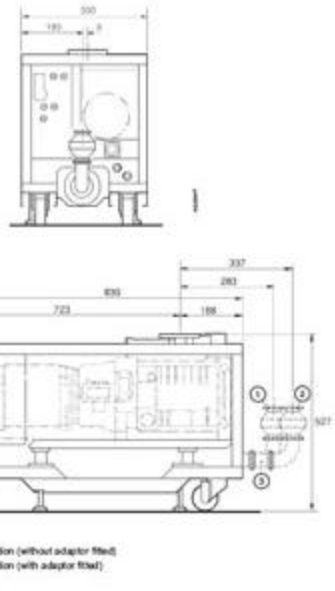
- End effector for transferring the top window.
- End effector for transferring the lower tile.
- Frame for the top window.
- Frame for the lower tile.
- End effector for holding and placing the indium seal.
- Platform in the photocathode chamber which will have electrical contacts.
- Platform in the scrubber chamber having electrical contacts.
- Design of the external support frame.



- The frames for each part will be slightly different due to the different electrical contacts that are needed.
- Use of the frame will facilitate electrical connection between the part and chamber platform.
- Metal clips will be used to clamp the part into the frame.

Component Selection

- Pumps
- Roughing pump
  - Varian dry scroll pump
    - Used in the beginning
  - Edwards QDP80 dry pump
    - Facility pump
- High vacuum pumps
  - Ion pumps
    - Varian
    - Gamma Vacuum
    - Duniway
  - Turbo pumps
    - Leybold 360
    - Alcatel 900
  - In the scrubber and the photocathode subsystems the preferred pump is a turbo pump over an ion pump due to its ability to withstand large gas loads.
  - At the most extreme end of vacuum the ion pump has the advantage but for this application a turbo pump is more that sufficient.

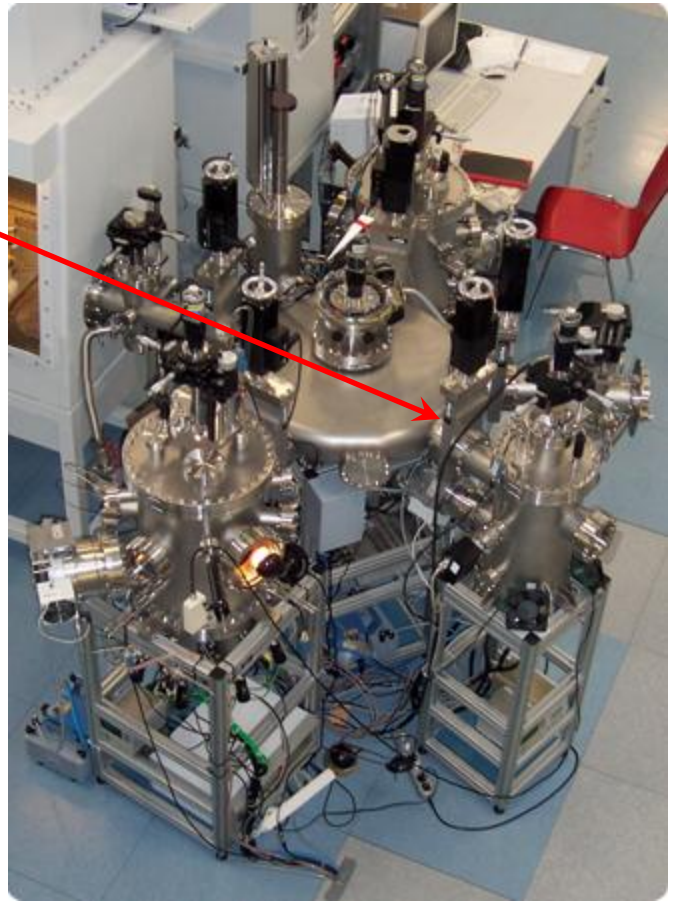


Components

- Valves
  - All metal valves
    - This are by far the most expensive, in this case $60K each
    - This has the most limited life, 5K cycles for DN250
    - This weighs the most, 344 lbs. for DN250
    - This has the largest insertion length, 5.91 inches
    - This are the best for UHV and XHV applications, < 1 x 10^{-10} torr
    - Dry lubricant on bearings
  - Metal bonnet with o-ring on seal plate
    - This is the middle price, in this case $7.3K each
    - This has a life, 50K cycles for DN250
    - This weighs 114 lbs. for DN250
    - This has an insertion length, 3.94 inches
    - This works quite well for UHV applications, 1 x 10^{-10} torr
    - Dry lubricant on bearings
  - O-ring bonnet with o-ring on seal plate
    - This is the least expensive, in this case $5.9K each
    - This has the longest life, 200K cycles for DN250
    - This weighs the least, 86 lbs. for DN250
    - This has the shortest insertion length, 3.15 inches
    - These are good for high vacuum (10^{-8} torr) applications
    - Grease on bearings

Components

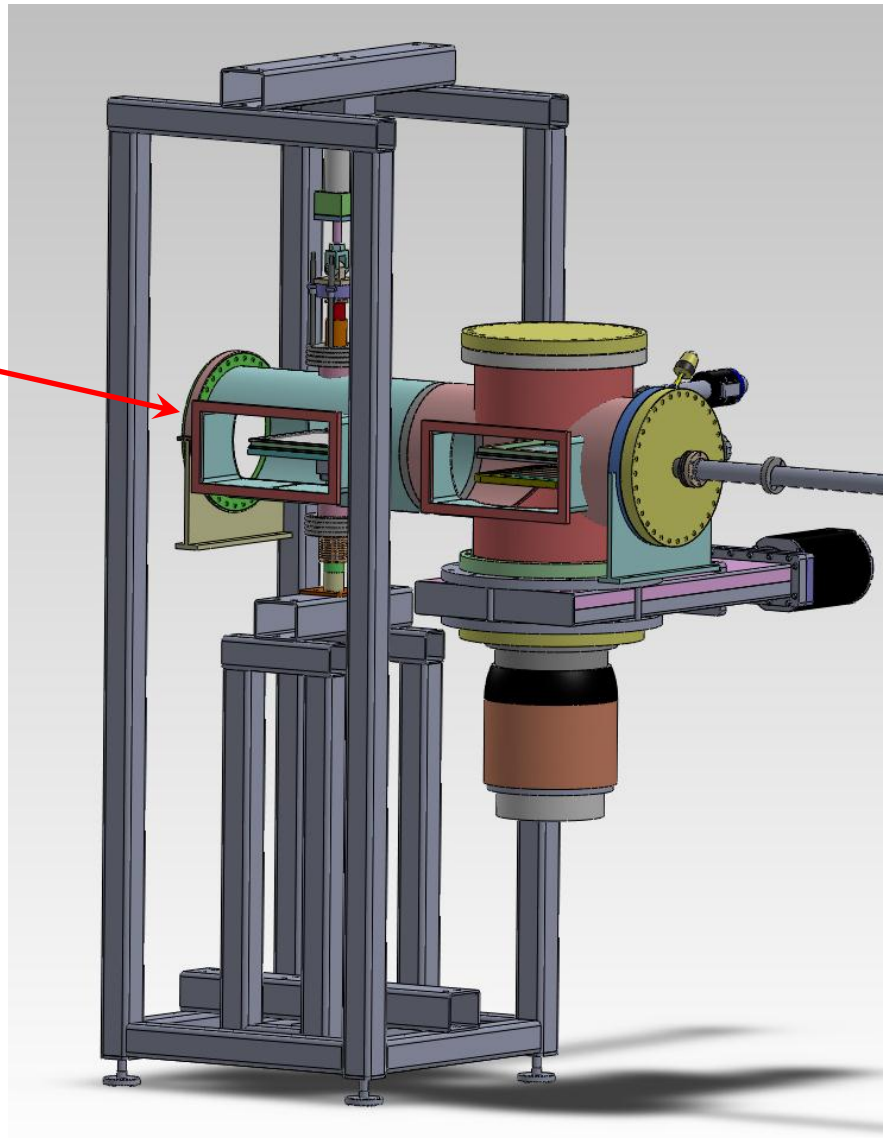
- Gate Valves
  - Current design shows the metal bonnet sealed valve.
    - Good vacuum range
    - Reasonable cost
    - Good bakeout temperature, 250 C.
    - Possible to replace Viton o-ring with Kalrez o-ring.
  - All metal valve is a possibility
    - Higher cost
    - Very large weight
      - Will have to design supports for the valve independent of the vacuum chambers.
    - Very good bakeout temperature, 300 C.
  - Question comes down to getting to the absolute lowest outgassing rate and the least gaseous contamination.
  - This has to be compared to the materials that are being put into the system and whether they pose a bigger problem than what can come from the metal bonnet sealed valve.
  - There are many UHV surface science systems that use valves of this type.

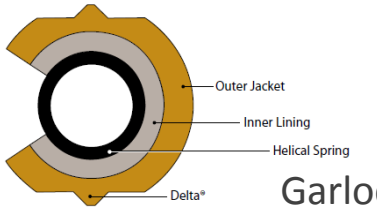


OLED system – VG Scienta

Components

- Load-lock Doors
  - Three ways to go: Viton, Kalrez, & metal
- Viton
  - Bakeable 200 C
- Kalrez
  - Bakeable 250 C
  - Good outgassing
  - More costly
- Metal
  - Helicoflex
    - May require large compression load.
    - Bakeable to 400 C





Garlock Helicoflex Δ Seal

Component selection

- Gauges
  - In this case a hot filament ion gauge was chosen so that it would evaporate off any contaminates that got on it.
  - The gas analyzer has an electron multiplier for use at UHV.
  - Both units have a computer interface: the ion gauge has RS-485, and the gas analyzer has and Ethernet Port.

Item #	Qty	Part #	Description
1	3	350507-F-T1	350 series UHV ion gauge controller ** ½ rack mount ** Reads one series 274 UHV nude Bayard-Alpert gauge ** Reads two Convectron gauges ** 3-line display ** Electron bombardment degas ** Remote input/output interface ** RS-232 or RS-485 switchable ** 4 setpoint relays ** Torr readout ** 115 v.
2	3	274042	UHV Nude Gauges ** Dual thoria-coated iridium filaments ** 2.75" CF flange ** Pin guard/locking strain relief
3	3	275238	Convectron gauge ** Gold-plated tungsten filament ** 2.75" CF flange
4	3	275196	Convectron gauge ** Gold-plated tungsten filament ** KF25 flange
5	3	350004-C	UHV nude ion gauge cable (10 ft length) ** Bakeable to 150 c
6	3	303040-10	Dual Convectron gauge cable (10 ft length)

Item	Units	Description
1	1 ea.	**Dycor LC-D200M Mass Spectrometer** Includes LC-D Series Electronics unit and Analyzer Head, with following features 1 1-200 AMU Range 1 Open Ion Source 1 Faraday Cup Detector 1 Channel Plate Electron Multiplier **1 Ethernet Port** 1 24VDC external power supply 1 System 200 software for Windows 98 through Windows 7 The System 200 software includes the same graphical user interface as the System 2000 software, but with a subset of the features of the System 2000 software. **PC not included with system.** PC supplied by customer must include the following minimum features: IBM compatible Pentium-class processor, with Windows 98 through Windows 7 capabilities

Estimated Material Cost

- Overall

Material Estimate

	Standard	All Metal
Single Tile System	$191,884	$297,424
Photocathode Coating Subsystem	$56,915	$56,915
Scrubber Station	$57,148	$57,148
Indium Sealing Subsystem	$24,843	$24,843
Loadlock Subsystem	$35,678	$35,678
Gate Valves - Subsystem Isolation (2)	$16,300	$119,840
Frame(s)	$1,000	$3,000

Estimated Cost

- Photocathode Subsystem

Photocathode Coating Subsystem	$56,915		
1) Vacuum Chamber			
a) Chamber	$6,175		Quote
2) Heater and Controls			
a) Heater Assembly	$2,550		Quote
b) Heater Brackets	$150		Estimate
c) Heater Controls	$3,250		Quote
3) Vacuum Valves			
a) Throttling Gate Valve	$5,737		Catalog
b) Roughing Valve	$480		Web
c) Venting Valve	$464		Web
d) Foreline Valve	$414		web
4) Pumping			
a) Turbo Pump	$4,600		Web
b) Controller	$1,900		Estimate
c) Cable	$180		Estimate
5) Vacuum Instrumentation			
a) Residual Gas Analyzer	$9,060		Quote
b) High Vacuum Gauge	$552		Quote
c) Low Vacuum Gauge	$170		Quote
d) Gauge Controller	$2,366		Quote
e) HV Gauge Cable	$189		Quote
f) LV Gauge Cable	$100		Quote
6) Gas Control			
a) Mass Flow Controller	$1,263		Web
b) Capacitance Diaphragm Gauge	$2,012		Quote
c) Monitor for MFC	$1,077		Web
d) Monitor Readout for CDG	$1,517		Quote
e) Cable for MFC	$66		Web
f) Cable for CDG	$239		Quote
7) Sample Transfer			
a) Manipulator	$4,528		Quote
b) End Effector	$1,050		Quote
c) Spatula	$400		Estimate
8) Coating Source			
a) Chamber	$5,000		Estimate
b) Source Holder	$177		Web
c) Electrical Feedthrough (2)	$294		Web
d) Temperature Feedthrough	$455		Web
e) Source Container Well	$500		Estimate

Estimated Cost

- Load lock Substation

Load lock Subsystem						$35,678		
	1)	Vacuum Chamber						
	a)	Chamber				$8,415		Quote
	2)	Heater and Controls						
	a)	Heater Assembly				$2,550		Quote
	b)	Heater Brackets				$150		Estimate
	c)	Heater Controls				$3,250		Quote
	3)	Vacuum Valves						
	a)	Gate Valve				$3,920		Quote
	b)	Roughing Valve				$480		Web
	c)	Venting Valve				$464		Web
	d)	Foreline Valve				$414		Web
	4)	Pumping						
	a)	Turbo Pump				$4,600		Web
	b)	Controller				$1,900		Estimate
	c)	Cable				$180		Estimate
	5)	Vacuum Instrumentation						
	a)	High Vacuum Gauge				$552		Quote
	b)	Low Vacuum Gauge				$170		Quote
	c)	Gauge Controller				$2,366		Quote
	d)	HV Gauge Cable				$189		Quote
	e)	LV Gauge Cable				$100		Quote
	7)	Sample Transfer						
	a)	Manipulator				$4,528		Quote
	b)	End Effector				$1,050		Quote
	c)	Spatula				$400		Estimate

Estimated Cost

- Indium Sealing Subsystem

Indium Sealing Subsystem						$24,843		
	1) Vacuum Chamber							
	a) Chamber					$7,780		Quote
	2) Heater and Controls							
	a) Heater Assembly					$2,550		Quote
	b) Heater Brackets					$150		Estimate
	c) Heater Controls					$3,250		Quote
	3) Pumping							
	a)	Ion Pump				$2,770		Web
	b)	Controller				$2,030		Web
	c)	Cable				$335		Web
	4) Sample Transfer							
	a) Manipulator					$4,528		Quote
	b) End Effector					$1,050		Quote
	c) Spatula					$400		Estimate

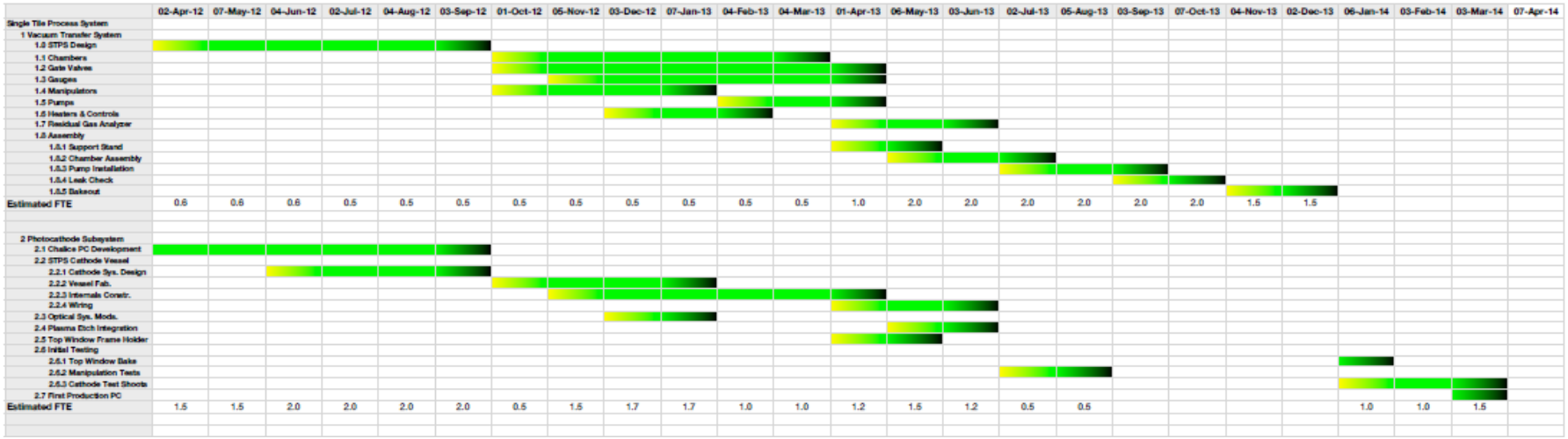
Estimated Cost

- Scrubber Subsystem

Scrubber Subsystem		$57,148	
1)	Vacuum Chamber		
a)	Chamber	$7,780	Quote
b)	Scrubber Element	5,000	WAG
2)	Heater and Controls		
a)	Heater Assembly	$2,550	Quote
b)	Heater Brackets	$150	Estimate
c)	Heater Controls	$3,250	Quote
3)	Vacuum Valves		
a)	Gate Valve	$8,350	Quote
b)	Roughing Valve	$480	Web
c)	Venting Valve	$464	Web
d)	Foreline Valve	$414	Web
4)	Pumping		
a)	Turbo Pump	$9,500	Web
b)	Controller	$1,900	Estimate
c)	Cable	$180	Estimate
5)	Vacuum Instrumentation		
a)	Residual Gas Analyzer	$7,775	Quote
b)	High Vacuum Gauge	$552	Quote
c)	Low Vacuum Gauge	$170	Quote
d)	Gauge Controller	$2,366	Quote
e)	HV Gauge Cable	$189	Quote
f)	LV Gauge Cable	$100	Quote
7)	Sample Transfer		
a)	Manipulator	$4,528	Quote
b)	End Effector	$1,050	Quote
c)	Spatula	$400	Estimate

Schedule

- Copy of the schedule that Bob Wagner compiled.



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Single Tile Process System																								
1 Vacuum Transfer System																								
1.0 STPS Design																								
1.1 Chambers																								
1.2 Gate Valves																								
1.3 Gauges																								
1.4 Manipulators																								
1.5 Pumps																								
1.6 Heaters & Controls																								
1.7 Residual Gas Analyzer																								
1.8 Assembly																								
1.8.1 Support Stand																								
1.8.2 Chamber Assembly																								
1.8.3 Pump Installation																								
1.8.4 Leak Check																								
1.8.5 Bakeout																								
Estimated FTE	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	2.0	2.0	2.0	2.0	2.0	2.0	1.5	1.5				
2 Photocathode Subsystem																								
2.1 Chalice PC Development																								
2.2 STPS Cathode Vessel																								
2.2.1 Cathode Sys. Design																								
2.2.2 Vessel Fab.																								
2.2.3 Internals Constr.																								
2.2.4 Wiring																								
2.3 Optical Sys. Mods.																								
2.4 Plasma Etch Integration																								
2.5 Top Window Frame Holder																								
2.6 Initial Testing																								
2.6.1 Top Window Bake																								
2.6.2 Manipulation Tests																								
2.6.3 Cathode Test Shoots																								
2.7 First Production PC																								
Estimated FTE	1.5	1.5	2.0	2.0	2.0	2.0	0.5	1.5	1.7	1.7	1.0	1.0	1.2	1.5	1.2	0.5	0.5					1.0	1.0	1.5	

Finish

- Any Questions?

- Thanks to
  - Ron Kmak
  - Marc Kupfer
  - Robert Wagner
  - Jeff Williams
  - Michael Ackeret, Transfer Engineering
  - Tom Bogdan, MDC Vacuum
  - Ken Coates, Thermionics Northwest
  - Scott Dix, Vacuum One
  - Hans Luedi, Midwest Vacuum